Benefiting from Technological Innovation Through Patent Strategy:

A Case Study of A Textile Company in China[1]

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1. Introduction

Technological innovation is now becoming the most important driver of competitive success in many industries (Porter, 1985; Teece, 1986; Barney, 1986; Giovanni, 1988; Burgelman, 1988; Schilling, 2005). The increasing importance of innovation is due in part to the globalization of markets. To survive in the intensive global competition, firms must be innovative in technological changes. It is not enough for a company to be innovative. If it wants to be successful it must be more innovative than its competitors. Nevertheless in the real world technological innovation has no inherent capacity to guarantee the improvement of companies' performance. Getting the technology innovation right is just a prerequisite for attaining or reinforcing a competitive advantage. It is not sufficient to capture the benefit created by technological innovation (Roberts and Berry, 1985; Teece, 1986; Tripsas, 1997; Sheremata, 2004). A crucial element of formulating a firm's technological innovation strategy is determining whether and how to protect its technological innovation in order to be the primary beneficiary of the innovation's rewards. As far as technological innovation protection is concerned, patents have turned into a high priority of management in today's global economy (Grindley and Teece, 1997; Rivette and Kline, 2000; Xu, 2003).

In China, as well as in other emerging developing countries, technological innovation is now the most highlighted issue in its fast growing economy. But things are different between developed countries where a tight IPR regime has already been established and developing countries whose IPR regime is weak and fragile. Whether and to what degree to protect a technological innovation by means of patenting is actually more complex and ambiguous in the latter ones. A growing number of literatures attempted to understand the relationship and interaction between innovation, patenting and benefiting in China's practice of technological innovation. But most of them focus on high-tech industry in the economically developed coastal regions whereas the traditional industries and underdeveloped regions remain ignored.

This paper focuses on the practice of technological innovation in a state owned enterprises (SOE) which operates in traditional industry and is located in an underdeveloped region of a

1 This article is based on work carried out under Soft Science Project of State Intellectual Property Office of People's Republic China "Investigation and Case Study of The Situation of Intellectual Property Rights In Sichuan Import & Export Enterprises" and the Youth Science and Technology Fund of University of Electronic Science and Technology of China (JX04047)

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developing country. It is about best practice of benefiting from technological innovation through patent strategy in this company. We try to determine the mechanism of how this company benefits from technological innovation through patent strategy. We developed a framework with four key dimensions to understand and analyze all the issues of patenting practice observed in this case.

In this paper, we begin with a theoretical overview to discuss the functions and the relevant effectiveness of patent protection, to analyze the strategic uses of patent as well as the patent strategy in the firm context. Second, we explain our research methodology. Third, we introduce the case of Grace Group we studied and the general background of China's IPR protection system. Fourth, we picture Grace's patent strategy and described the formulation and implementation of its patent strategy. When analyzing the strategic choice of Grace's patenting activities, we introduce a four-dimensional framework. Fifth, we make a conclusion and present implications according to our study. In the final section we foresee the future research.

2. Theoretical Overview

A patent is an exclusive right granted for an invention, which is a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem. In order to be patentable, the invention must fulfill certain conditions. Patent protection means that the invention cannot be commercially made, used, distributed or sold without the patent owner's consent. These patent rights are usually enforced in a court, which, in most systems, holds the authority to stop patent infringement. Conversely, a court can also declare a patent invalid upon a successful challenge by a third party.[5] In China, there are three types of patents: invention, utility mode and design. Invention means any new technical solution relating to a product, a process or improvement thereof. Utility mode means any new technical solution relating to the shape, the structure, or their combination, of a product, which is fit for practical use. Design means any new design of the shape, the pattern or their combination, or the combination of the colors with shape or pattern, of a product, which creates an aesthetic feeling and is fit for industrial application.[6]

Patent protection is often viewed as a decisive tool to secure sufficient payback for R&D investments, especially in an environment of increased national and international technological competition. The rising number of patent applications at the State IPR Office of China seems to support this argument (See Figure 1). Ashton and Sen (1988) argued that patent information provides a unique planning resource for managing a firm's technology or product development and for systematically evaluating its competitive position relative to other companies in a market area. Levin, Klevorick, Nelson, and Winter (1987) grouped industries according to their use of patent protection. It was found that those industries, which regarded patent protection as being effective, also ranked other means of securing competitive advantage highest. Thus it can be argued that patent protection is not the only or

5 Source: World Intellectual Property Organization http://www.wipo.int/patentscope/en/patents_faq.html#patent
6 Source: State Intellectual Property Office of People's Republic China: Implementing Regulations of the Patent Law of the People's Republic of China

the most important mechanism to achieve competitive advantages. Patent protection has to be viewed as one element within an overall mix of instruments in securing the competitive edge. Wyatt, Bertin and Pavitt (1985) evaluated the effectiveness and initial use of patent protection according to empirical investigations on patent data at the firm level. They argued that among all other means of protecting technological knowledge patents are considered to be the most valuable. Levin et al (1987) pointed out that this result differs according to the nature of the innovation. For process innovations, secrecy is viewed as an appropriate means of protection, whereas for product innovations patents are considered to be more effective. Teece (1986) argued that patents rarely confer perfect appropriability although they do afford considerable protection on new chemical products and rather simple mechanical inventions. Many patents can be "invented around" at modest costs. They are especially ineffective at protecting process innovations. Often patents provide little protection because the legal requirements for upholding their validity or for proving their infringement are high.

Strategic use of patenting is focused in many literatures. Levin et al (1987) and Cohen et al. (2000) suggested that patents are featured as an effective appropriability strategy in only a few industries. Arora, Ceccagnoli, and Cohen (2004) found that patents on average provide a positive premium for only a small fraction of innovations, although premium on patented innovations are positive and highly skewed. The positive premium can result from greater net expected returns from patenting an innovation relative to not patenting it. Ashton and Sen (1988) identify five major business applications for patenting trend analysis. They are technology competition analysis, new venture evaluation, patent portfolio management, R&D management and product area surveillance. Cohen et al (2002) identified three strategic uses of patents: to block other firms from patenting an invention, to use in negotiations for cross-licensing or other forms of technology access, and to prevent infringement suits. Other scholars added prevent copying, enhance reputation, licensing revenue, and measure performance in his category. Arundel and Patel (2003) defined two broad types of strategic patenting: defensive and offensive strategic patenting. The former is to stop other firms from patenting one of its inventions and suing it for infringement, even though the firm does not need a patent on this particular invention in order to earn a return on its investments in innovation. The later is to prevent or block other firms from patenting inventions that are similar, but not identical, to the invention that they plan to commercialize. Vermeulen (2003) summarized four strategic uses for patents: marketing benefit, revenue source, bargaining chip, and industry control.

Patent strategy is a tool to ensure that companies can keep their competitive advantage they have earned. It is part of the technology strategy which is to achieve and maintain competitive advantage. Getting the "right" patents by the right "means", at the "right" time and using them in the right "way" is a strategic process. Bokerwitz (1993) analyzed the links between technology strategy, business strategy and patent strategy. He developed a framework to focus on patent strategy with two most important variables: the degree of prior patenting in a field and the rate of change in the field. Ernst (1998) employed a general framework to characterize patent strategy of firms with two different dimensions: patent activity and patent quality. Patent activity measures the level of R&D activities, whereas

patent quality measures the impact of these activities. He outlined patent portfolios by three elements: the relative patent position, the technology attractiveness and the technology importance. When explaining why innovating firms often fail to obtain significant economic returns from an innovation while customers, imitators and other industry participants benefit, Teece (1986) introduced a framework with three fundamental building blocks: the appropriability regime, complementary assets, and the dominant design paradigm. We contribute to this literature by providing an analytical framework based on Teece's theoretical foundation to analyze patent strategy at the firm level. Our framework consists of four criteria: the accessibility of complementary assets, the effectiveness of patent protection, the cost of imitation, and the expected return from exclusive use of the technological innovation.

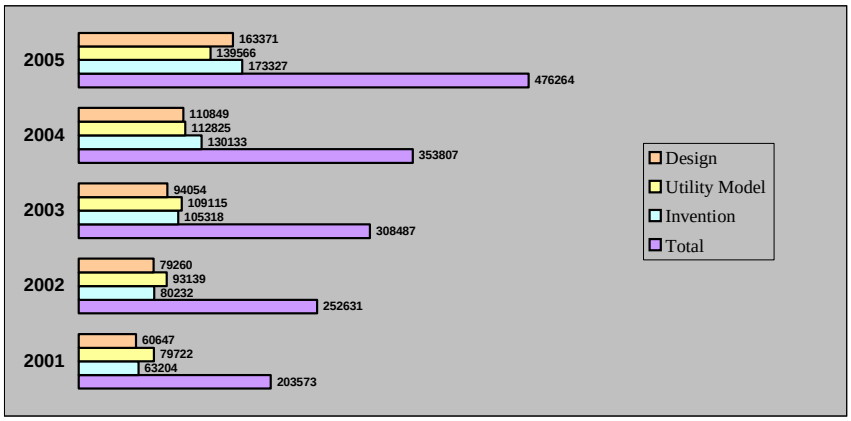

Figure 1. Applications for Three Types of Patents Received from Home and Abroad, 2001-2005[7]

3. Research Methodology

We used the case study methodology to understand the patent strategy of this company and to explain all the issues emerging from formulation and implementation of this patent strategy. In organizational research, the case study method is one of the frequently adopted research methods, and the appropriateness of the method is well documented (Eisenhardt, 1989; Pettigrew, 1990). Different sources of evidence are utilized, including questionnaire, interviews, direct observation, archives and statistics.

In the data collection phase, we used one questionnaire, which is part of the Project entitled "Investigation and Case Study of The Situation of Intellectual Property Rights In Sichuan Import & Export Enterprises", and 15 interviews, including the President and Chairman of the board, the Vice-general Manager, the directors of the middle-level management team from four different sections, the engineers and the workers. Typically each interview lasted for 1 hour at the old location of Grace as well as the new site. The interview phases lasted 6 non-consecutive weeks. All of the interviews were well recorded but not taped since the informants were reluctant to share their views on record. Informal discussions with the

7 Source: State Intellectual Property Office of People's Republic China: http://www.sipo.gov.cn/sipo_English/statistics

members of the organization provided us with a better understanding of the important themes underlying the firm's practice of technological innovation.

In the data clarification and complementation phase, we contacted Grace's managers via email correspondence and telephone discussions for further information and data, and to clarify unclear points in the previous interviews.
In the data analysis phase, we introduced a framework to analyze the Grace's patent strategy.

4. Case Description

4.1 General background

4.1.1 China's Textile Industry

China's textile industry has become an important industry with tangible competitiveness in the international market. The National Development and Reform Commission reported China's textile sales reached 3.3 trillion Yuan (US$408 billion) in 2005, surging 115.7 percent from 2001.[8] However, at the same time we observed that the profits of Chinese textile exporters did not rise simultaneously, and many even witnessed a drop in profits. In the first half of 2005, due to the rapid growth of apparel supply in Chinese market, the apparel price index dropped 2.1 percentage points year on year to 97.6, according to figures from the Ministry of Commerce of China.[9] The reason behind may be both external and internal.

From external perspective, in domestic market, the expanding investment has led to a serious problem of oversupply as well as disorder in this industry. A recent investigation by the Ministry of Commerce showed that 86.9% of the 84 categories of textile goods in China are oversupplied, demonstrating the urgency for China's textile industry to regroup and upgrade its technology. In recent years, the investment scale in the textile industry has been expanding. In the first five months of 2005, investment in this industry jumped 39.7% year on year causing the supply to increase by a large margin.[5] Besides, in international market increasing and diversified international trade protectionism has affected and will continue to reduce the profit potential of Chinese textile enterprises. A series of restrictive measures taken by the United States and the European Union against Chinese textile exports further increased the textile goods supplies in the domestic market.

From internal perspective, Chinese textile enterprises are still weak in innovation, research and development, lacking core competencies and brand recognition. The firms are on the lowest level of the value added chain of the global textile trade. The competencies of the textile firms are based on low labor costs which now no longer brings them much profit. They have to widen their profit margins to cushion their firms against future shocks from changes in global trade rules as well as international market conditions. Therefore, their survival and sustainable development depend on whether these companies can restructure their competitive strategy on the base of innovation to acquire competitive advantage, and

8 Source: National Development and Reform Commission, *Analysis Report On Textile Industry Operation 2005 and Trends Prediction 2006*, http://www.ndrc.gov.cn/jjyx/gjyx/fz/t20060310_62680.htm
9 Source: China Textile News 2005-08-05

whether they can implement their innovation strategy according to the changes in domestic and global competition.

4.1.2 China's Intellectual Property Rights Protection System

China's legal system of IPR protection consists of two parts. One is IPR protection laws and regulations, the other is IPR management and protection bodies. The laws and regulations protecting IPR have been established in China since 1985. Two very important laws, the Patent Law of China and the Judicial Interpretation by the Supreme People's Court & The Supreme People's Procuratorate on Several Issues of Concrete Application of Laws in Handling Criminal Cases of Infringing Intellectual Property, were issued in 2000 and 2004 respectively.

The IPR management body consists of the State Intellectual Property Office of the People's Republic of China, State Administration for Industry & Commerce, and The Press and Publication Administration. The IPR protection body includes judicial bodies of IPR protection and administrative bodies of IPR protection. The former is law Courts and procuratorates. The later are Ministry of Public Security, Ministry of Information Industry, Ministry of Commerce, Customs General Administration, State Administration for Industry and Commerce, The General Administration of Quality Supervision Inspection and Quarantine (AQSIQ), National Copyright Administration, State Food and Drug Administration, State Intellectual Property Bureau, Legislative Affairs Office of State Council.

4.2 Grace Group

Yibin Grace Group Limited Corporation is located in Yibin city of Sichuan province in southwest China. It is a state-owned- enterprise and grows out of a small chemical fiber factory founded in 1984. Till 1997 it was still a small factory on the edge of bankruptcy. 1997 was a milestone in the history of Grace marked by the change of top management and the start to invent a revolutionary technology named "2S". Since then Grace experienced a high increase at an average annual rate of 35%. Now it is one of the world's largest manufacturers of viscose rayon filament yarn, rayon embroidery thread and hand knitted garments with 3 billion RMB total assets and 12,000 employees. The domestic market share reached 25% and international market share is 15% in 2005. Grace has 30 economic indicators ranking first in China's chemical fiber industry, including labor-productivity, return on equity, profit margin and growth rate of investment return. Their products are exported to 29 counties all over the world.[10]

Grace has three outstanding occurrences about technological innovation which are breaking common sense in China. First, the Grace Corporation benefits dramatically and continually from a technological innovation, which is very easy to be imitated. This unique technological innovation has strongly supported the high growth of Grace in the past eight years. Second, the annual R&D as percentage of sales is 3% to 9% in the past five years far beyond the average level of 0.2% to 0.5% in China's textile companies.[7] Third, the number of patents in

10 Source: Publicity Department, Yibin Grace Group Co., Ltd.

Grace is much bigger than the average level of the 64 investigated import and export enterprises in Sichuan province. Grace has an obvious advantage over its competitors in terms of patents (see Table1). The number of patents of Grace is also much higher than the average level of the 64 investigated I&E enterprises in Sichuan province (see Table2).

Table1

Comparison of the Number of Patents between Grace and Its Main Competitors[11]

Numbers	Invention	Utility Model	Design
Grace	16	45	26
Baoding Swan	8	3	0
Jilin	6	3	0
Xinxiang	15	20	0

Table 2

Comparison of the Number of Patents between Grace and the Other I&E Firms in Sichuan[12]

	Patents	Remarks
Grace	87	No international patent
Average level of high-tech companies	9.3	Average level of 24 investigated Import & Export-led high-tech companies in Sichuan province
Average level of mid & low-tech companies	5.5	Average level of 40 investigated Import & Export-led mid & low-tech companies in Sichuan province

Grace has 87 patents but none of them is international. There are two reasons for this. On the one hand, in developed countries like Germany and Japan, Grace's core technologies have no chance to be infringed. These technologies belong to the semi-continuous-spinning technology. They are no longer in use in developed countries. On the other hand, in developing countries like India and Pakistan where the same semi-continuous-spinning technology is still in use, Grace's core inventions have almost no chance to be protected by patent. IPR awareness and IPR protection regime in these countries are weak. If Grace patents its core inventions it has to disclose all the technological details. But once these patents are infringed it is almost impossible to protect them because of the high cost of lawsuits and low chance to win.

5. Grace's Patent strategy

5.1 What is it about and how was it formulated?

Grace's patent strategy is an important part of its technological innovation strategy. A crucial element of formulating a firm's technological innovation strategy is to determine whether and how to protect its technological innovation (Schilling, 2005). When explaining the patent strategy of Grace, the Chairman and President Feng Tao said: "The most important task in modern enterprises is managing knowledge. The primary question of managing knowledge is

11 Source: State Intellectual Property Office of People's Republic of China 2006-9-6

12 Source: Soft Science Project of State Intellectual Property Office of People's Republic China "Investigation and Case Study of The Situation of Intellectual Property Rights In Sichuan Import & Export Enterprises"

to strategically recognize the importance of IPR. But intangible assets are usually ignored in most companies in China, especially among the state owned enterprises. It never appears on a firm's balance sheet and is never involved in performance evaluation by the supervision bodies of state owned assets. In the past eight years, Grace's success highly depended on our technological innovation strategy. Nevertheless, our economic performance can not benefit from isolated technological innovation but from support of the patent strategy ".

Grace's patent strategy consists of two stages. The first stage is to get the innovative technologies through endogenous technological innovation and then patent these self-developed technologies. The second stage is to patent the peripheral technologies of the core patent and other inventions, as many as possible.

The first stage of patenting is defensive strategic patenting with the purpose of acquiring an exclusive right to commercialize as well as stopping other firms from patenting its inventions and suing it for infringement. Grace patented the revolutionary invention 2S technology in 2001. 2S is a radical innovation which is described as an A-bomb in textile industry. It breaks the traditional spinning technology of the past century in the fiber industry. The typical methods to raise output of spinning machines are to lengthen the spinner or to speed up spinning. But 2S do it differently. It produces two yarns at the same time. With 2S the textile company can dramatically increase its production at very low cost. The fiber industry is a labor-intensive and low value-added industry. Cost of production is always the most important competitive factor. 2S technology successfully helps Grace to be the cost leader in this industry. But 2S is not a complex technology. It is simple that almost any experts in textile machinery can find out about the technological secret as long as to take a close look to this mechanical invention. How to protect its invention, patent or not? Grace was in a dilemma at the time when 2S was invented. On the one hand, patenting means invention disclosure but not necessarily means perfect protection. It was in 2001 when the Patent Law of China just has been issued for one year and the IPR protection regime still hasn't taken shape. On the other hand, no patenting means keeping 2S a proprietary technology but just temporarily. Imitating is only a question of time for competitors. With the floating of personnel, it's almost impossible to prevent 2S from being imitated. At last the top management decided to patent 2S. As the Chairman and President, as well as one of the four inventors of 2S, commented: "This is a risky decision. It is based on the belief in law". In fact, Grace doesn't need 2S patent to earn a return on its investments in this invention. The benefit from increased production caused by 2S has already made up its investments and provided Grace great amount of profit. So the main purpose of this patent is to use it exclusively and to block other firms from patenting it.

The second stage is offensive strategic patenting with much stronger strategic intention of preventing or blocking other firms from patenting inventions that are similar to the invention or go around this invention. The purpose of these firms is to commercialize similar technologies or to increase negotiation power for cross-licensing or other forms of technology access. In this stage Grace patented as many as possible the peripheral technologies of 2S as well as any other inventions. In the process of technological evolution, once a core technology, has settled in a particular kind of design, further advances are concentrated in

peripheral technologies. If the peripheral technologies of 2S are patented by the competitors, Grace will be put into an inferior situation in negotiation. Grace has to pay a high price for the license of these peripheral technologies and consequently the cost advantage supported by its core technology 2S will no longer exist. So Grace builds a patent family or "wall" around its core patent. This prevents other firms from patenting any peripheral technologies of 2S even though Grace doesn't intend to license these peripheral technologies itself.

5.2 How did Grace implement its patent strategy?

We try to understand the vital issues emerging from the implementation of Grace's patent strategy. We illustrate these issues from the aspects of patent creation, patent application and patent protection (see Figure 2).

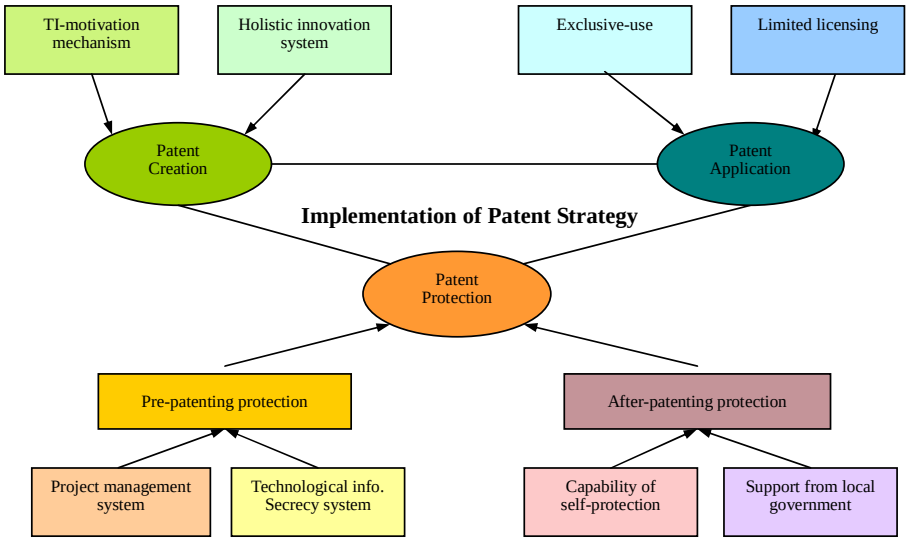

Figure 2. Implementation of Patent Strategy in Grace

5.2.1 Implementing patent strategy in the process of patent creation

IPR creation is the start of the implementation of patent strategy.

Grace's patent creation is characterized by its stimulating motivation mechanism of technological innovation. Grace offers a very stimulating incentive program to reward inventors. The firm allows its researchers and inventors to possess patents of their invention, to get rich and to obtain honor through their technological innovation even if the rewards they get exceeds their contribution. The Chairman said: "What we need to do is to overwhelmingly protect the creativity of our employees. We must provide them a stage for innovation, illuminate the stage, make ready for applause and stop catcalls". When it comes to encouraging invention, the most famous notion of the Chairman is "rather incorrectly reward 1,000 people than omit one person". He explained this is because of the complexity and immeasurability of R&D, and the change-with-time value of technological innovation. This policy boosted technological innovation in every section level. All the patents in Grace are self-developed by in-house R&D. But in recent years, we observed that the rewarding

policy tended to be stringent. Applications are sifted more carefully to separate the wheat from the chaff. Many rewards for invention changed from initial payment plus royalty to once-and –for-all-reward.

Grace's patent creation is based on a holistic innovation system. In Grace every employee is encouraged to be an inventor. Technological innovation is not just a mysterious, complicated and exclusive job for the senior researchers. Grace encourages invention by users. The percentage of the contribution of technological innovation projects by front-line users to the total contribution of all technological innovation projects is 42.8% in 2005.[13]

5.2.2 Implementing patent strategy in the process of patent application

Patent application refers to technological transfer like patent licensing. Patent licensing has never been Grace's free choice but a compelled remedial measure after being infringed. Grace would rather hold the 2S patent for exclusive use than license it to other companies. 2S patent is extremely vital to Grace's survival and development. It has fueled Grace's high growth at the annual rate of 35% in the past eight years. In 2005, 95% of the chemical fiber manufactures suffered loss but Grace continually made profit. 2S is just the open sesame. Grace's patent licensing is very limited and reluctant. It is a compromise between the company and the infringers. In 2003 Grace's 2S patent was illegally imitated by six competitors. The total supply in the market soared in that year directly resulting in a sharp decline in price and profit (see Figure3). Grace sued and won. But the spinners restructured and the illegally imitated 2S technology could not be destroyed or put out of use. The reason is that all these infringers are state owned companies in different provinces. The local government didn't want them to go bankrupt as it may lead to serious social problems such as unemployment. Of course, it would also be a great loss of social resources to destroy these spinners. As an agreement between Grace and the infringers, Grace was forced to license its 2S patent to these companies. This is the only case of Grace's patent licensing.

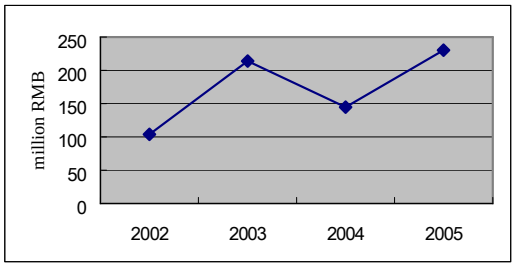

Figure3. Earning and Taxation in the past four years in Grace[14]

5.2.3 Implementing patent strategy in the process of patent protection

Patent protection is the most important part of the implementation of patent strategy in Grace. Patent protection penetrates the whole process of technological innovation including pre-patenting protection and after-patenting protection.

[13] Source: S&T Department, Yibin Grace Group Co., Ltd.
[14] Source: Publicity Department, Yibin Grace Group Co., Ltd

Pre-patenting protection

Pre-patenting protection is facilitated by two systems: technological innovation project management system and technological information secrecy system.

The first is to assess the novelty of technological innovation proposals before putting them into execution and after complete them. The purpose is to avoid unnecessary investment in patented technologies and to keep away from infringing other companies' patents. Grace has a very effective process management of technological innovation projects which consists of four stages: initiation, implementation, evaluation, and extension. In the stage of initiation, every application has a document retrieval process to identify the technological level and avoid redundancy and duplication of other company's IPR. In the evaluation stage, the second document retrieval should be conducted to see if there is a possibility of patent infringement. In the extension stage, Grace takes very careful steps. A report of extension and application must be submitted to the Science and Technology Administration Department, then to the head of the relevant sections and at last it goes to the S&T vice president for approval. This complicated procedure is a guarantee to stable operation. It is to minimize waste and loss, and bad effects on production by the application of immature technologies. At the same time this procedure is made to protect trade secrets and to safeguard the inventors' or researchers' benefits.

The second is to guarantee the ownership of the rights is assigned to the company. A very important step of building an efficient patent strategy is to make the employees of a company aware of the importance of confidentiality. Potentially patentable inventions need to be kept absolutely secret until a patent application has been filed. Grace has very strict technological information secrecy system. Every employee in Grace needs to sign a confidentiality agreement. We observed many slogans and rule-bulletins in the offices and workshops reminding the employees to pay attention to confidentiality in their daily work. A visit to the workshop has to pass a complicated procedure for approval.

After-patenting protection

After-patenting protection is to protect the core patents from being infringed and to suit the patent violators for their infringements. The case of 2S infringement 2004 is a good example to illustrate the practice of after-patenting protection in Grace. In 2003 2S patent was imitated by six competitors. Grace suffered a great loss in that year. Then they devoted great effort to protect this patent because it concerns the survival of Grace. Grace won the suit. The amount of exploitation fees from licensing agreements and compensation for the damage caused by the infringement of this patent has reached 109.6 million RMB as of the end of 2005.[15] It is absolutely unusual in China especially among SOEs. This case ranked "2004 Top Ten IPR Cases In China". In fact the most incentive to sue the patent violator is not for compensation but to keep the supply and price stable in domestic and international market. As the President and Chairman commented: "There is no option but to sue the infringers. We must do it at any cost. This patent is like pandora's box, once it is opened, no one can survive".

[15] Source: IPR Office, Yibin Grace Group Co., Ltd.

5.3 Why could its patent strategy successfully help Grace benefit from its technological innovation?

5.3.1 *Framework to analyze firm's patent strategy*

We introduce an analytical framework within which to understand and to explain the issues of patenting practice in Grace. Our framework consists of four key dimensions: the accessibility of complementary assets, the effectiveness of patent protection, the cost of imitation, and the expected return from exclusive use of the technological innovation. We'll give the definition to each dimension and analyze the situation of each dimension in Grace.

The accessibility of complementary assets

The accessibility of complementary assets refers to the ease and convenience with which a complementary asset can be utilized by users. It indicates extent of ease of commercializing innovations in firms. Teece's (1986) concept of complementary assets are defined as resources that are required to capture the benefits associated with a strategy, a technology, or an innovation. Teece highlighted the importance of complementary assets in understanding the performance implications of a new technology when he examined the reason why many innovators were unable to capture the economic rents flowing from their innovations. Teece divided complementary assets into three categories: generic assets, specialized assets and cospecialized assets. Generic assets are general-purpose assets which do not need to be tailored to the innovation in question. General purpose manufacturing equipment falls into this category. Specialized assets are those where there is unilateral dependence between the innovation and the complementary asset. Cospecialized assets are those for which there is a bilateral dependence. Rothaermel and Hill (2005) argued that the type of complementary assets necessary to commercialize the new technology is likely to be paramount in determining the performance consequences for incumbent firms. They considered that incumbent industry performance declines if the complementary assets necessary to commercialize the new technology are generic.

In this case the complementary assets to benefit from 2S are easy to achieve by any competitor in the industry. As far as Grace's core patent 2S is concerned, it is an output of process innovation which is often oriented toward improving the effectiveness or efficiency of production. The Director of Science and Technology Administration Office of Grace told us that 2S is not a complex technology but a simple one. It is a technological improvement based on the existing technologies and production equipments. No specialized resources needed to facilitate this technology. All our competitors have already have the resources to commercialize 2S.

The effectiveness of patent protection

The effectiveness of patent protection is an environmental factor which refers to the efficacy of legal mechanisms of protection. It is an exogenous variable in our framework which cannot be changed by the firms. We considered that the effectiveness of patent protection was not good in the past 5 years. The situation of China's IPR protection can be described as high IPR handling pressure on firms with weak IPR protecting regime of the country. On the one hand, according to comments from IPR Office of China, China has faced international

pressure on its handling of intellectual property rights five to ten years earlier than predicted. More and more Chinese companies have come under pressure from IPR issues with the rapid economic development in the country. On the other hand, the patent protecting regime is still weak in China. Much has been done to improve the situation but the problems have not been resolved yet. It is still too costly in terms of time and money to sue for patent infringement. 50 IPR service centers, which are responsible for receiving and handling complaints about IPR infringements and offering consulting services, have been set up in China's 31 provincial areas and some booming cities, but the effectiveness of the service provided by these agencies is questionable. At the same time, the efficiency of public resources utilization is low. Government financing is used neither to construct the platform for IPR service nor to train IPR personnel, but to finance some specific patenting projects. This leads to privatization of public resources and rent-seeking of public power. The IPR protection regime has not been properly integrated. Different departments function separately. This inevitably increases the cost of IPR protection for the firms. The Chinese government has taken actions to improve IPR protection, such as The Special Action of IPR Protection started in 2004. But southwest China remains ignored. Sichuan province, where Grace is in, was not in the list of key regions of IPR protection.

The cost of imitation

The cost of imitation are the economic expenses of imitating the patented technologies. It depends on the nature of these technologies. The cost of imitating Grace's core patent 2S is low. The director of Science and Technology Administration Department of Grace explained that although 2S was such a radical improvement of the traditional spinning technology in the past century, it was actually a simple technology. What's difficult is not producing the innovative spinner but getting the innovative idea. So there is almost no technological barrier to the imitators. As a matter of fact, six competitors had illegally but successfully imitate 2S in a short period of time at a low cost in 2003.

The expected return from exclusive use of the technological innovation

The expected return from exclusive use of the technological innovation is the anticipated economic output from exclusive use of the specific technological innovation. The expected return from Grace's invention 2S is dramatically huge. Grace's core product viscose filament yarn is homogenous product in the market. Profit of viscose filament yarn comes mainly from low cost manufacturing. The production cost of Grace's core product is 5000RMB per ton less than the average level of the industry. The price is around 40000RMB per ton. That is to say Grace has 5000RMB more profit than its competitors. In the past seven years Grace accumulated its production capacity to 50,000 tons at the expense of 1.8 billion RMB compared with 4 billion RMB that its competitors needed to pay.[16] The main contributor is 2S patent. The president commented: "Without 2S patent Grace could not survive, to say nothing of fast growth. The anticipated return from 2S is so obvious and tremendous that all our competitors dream of it".

We display the four dimensions in Figure 4. Then we get a four-to-four matrix of patent

[16] Source: Publicity Department, Yibin Grace Group Co., Ltd.

strategy and the relevant strategic choice in each niche.

5.3.2 Why did Grace choose this patent strategy?

According to our investigation, observation and discussion in Grace, we considered that Grace lies in the niche with a star in Figure 4. In this niche, the expected return from exclusive use of technological innovation is great, the effectiveness of patent protection is not good, the cost of imitation for competitors is low, and the complementary assets required to commercializing the innovation are easy to get.

Grace chose to patent its core invention of 2S because there is no other alternative. Even though patent protection regime is weak, patenting is better than no patenting, a little protection is better than no protection at all. Grace chose not to license 2S patent because the benefit of exclusive use of this patent is much bigger than the benefit of licensing.

5.3.3 Why could Grace successfully implement this patent strategy?

Grace's successful implementation of its patent strategy is due to internal and external factors, the strong capability of self-protection and the improved environment of IPR protection.

Strong capability of self-protection

Capability of self-protection includes capabilities to integrate and utilize external resources as well as internal resources. When the outside patent regime is weak, the inner capability of self-protection becomes very important. Patent protection is highly recognized by top management in Grace. The chairman and president of Grace explained: "The most important task in a modern enterprises is managing knowledge. The primary question is to strategically recognize the importance of patent. Then the patent strategy should be implemented by a sound and solid organizational system". Grace has a sound and solid multilevel IPR protection network. In 2003 a top management driven IPR office with seven employees was initiated. The number of the full-time employees on IPR protection in Grace ranks first among the 64 investigated I&E enterprises in Sichuan.[17] The director of IPR office reports directly to the Chairman and President. This design is unique as in most firms the IPR office usually is in the third level of the firm's hierarchy and is supervised by the Law Department or General Engineer Office. Grace's IPR protection network consists of full-time IPR administrators in the IPR office and part-time IPR protectors in every section level.

Improved environment of IPR protection in China

In recent years, Chinese government has taken multiple measures to improve the IPR protection in China. In the case of Grace Group, the local government provided great help for Grace's patent protection. Grace ranks "The Key Enterprises of IPR Protection" by the Yibin IPR Bureau and Sichuan IPR Bureau. The Sichuan IPR Bureau even set up an IPR database specifically for Grace. In the cases of patent infringement the local government also provided strong support to Grace as the director of IPR Office mentioned.

17 Source: Sichuan Soft Science Project "Investigation and Case Study of The Situation of Intellectual Property Rights In Sichuan Import & Export Enterprises"

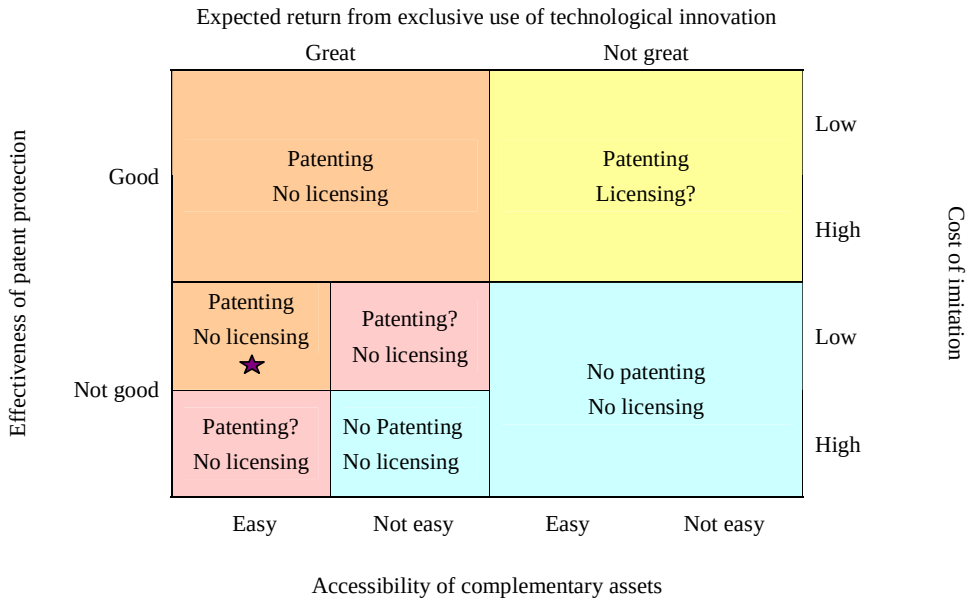

Figure 4. Framework to analyze patent strategy

6. Conclusion and Implication

6.1 Conclusions

We have four main findings in this case study.

Conclusion 1: technological innovation is the most significant source of Grace's eight years of high-speed growth. But the company cannot benefit from isolated technological innovation without a link to its patent strategy.

Conclusion 2: The patent strategy plays an important role to eliminate competitors, to guarantee the company's benefit from its technological innovation, to obtain and keep Grace's leading position among China's fiber manufacturers.

Conclusion 3: To maximize its benefit from this innovation, Grace would rather hold the patent than license it. All the existing licenses are not free choices but compelled remedial measures after infringements.

Conclusion 4: Grace's patent strategy is facilitated by a strong IPR protection network consisting of full-time staff in IPR office and part-time IPR protectors in every section level. Meanwhile, Grace's patent strategy gains high recognit

6.2 Implications

We preliminarily got five implications from the four-dimensional patent strategy matrix according to our analysis and the discussion with the managers in Grace.

Implication 1: When effectiveness of patent protection is good and expected return from exclusive use of technological innovation is great, firms are most likely to patent their inventions and not to license patents without consideration of the accessibility of complementary assets required for commercializing innovation and the cost of imitation for

its competitors. This situation increases the tendency to patent but decrease the tendency to license. To maximize its benefit from the innovation, company would rather hold the patent in hand than to license to its rivals.

Implication 2: When expected return from exclusive use of technological innovation is not great and the effectiveness of patent protection is not good, firms are most likely not to patent their innovations. They would rather protect their innovation by trade secret.

Implication 3: When effectiveness of patent protection is not good and expected return from exclusive use of technological innovation is great, firm's choice of patenting depends on the combination of the cost of imitation and the accessibility of complementary assets.

Implication 4: When effectiveness of patent protection is good, but the expected return from exclusive use of technological innovation is not great, firms tend to patent their innovation rather than protect by trade secret. Under such condition, the firm's patenting is so called strategic patenting with the purpose of acquiring technological advantage to build up technological barrier to prevent from being attracted by their competitors or with the desire of licensing fee. So licensing decision depends on firms' strategic intention.

Implication 5: Effectiveness of patent protection conditions the propensity of firms to patent their innovation. When effectiveness of patent protection is good, not matter if the expected return from exclusive use of technological innovation is great or not, firms tend to patent their innovation rather than protect by trade secret. This implication is meaningful to policy makers. Chinese government needs to further improve IPR protection in China. Improving IPR protection regime is not the government's own wishful thinking or simply an unavoidable reaction to international IPR pressure. It is a realistic demand from the domestic firms.

7. Further Research

We introduced the four-dimensional framework of patent strategy in this paper. Further research can be toward two directions. First, how and to what extent do these four dimensions influence firm's patent strategy can be studied. We plan to do some quantitative research in this domain. Second, the five implications should be tested in a boarder context, such as different firms and different sectors. More firms from different industries should be studied in the future so as to reach a more generic conclusion and to have a deeper understanding of patent strategy in the firm context.

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